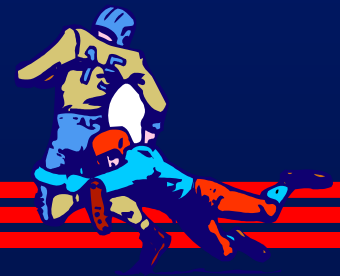


# ***HEAD INJURY***

***Thomas M. Howard, MD***  
***Sports Medicine***



# **Objectives**

1. To understand the epidemiology and classification of closed head injuries in athletes.
2. To understand the field-side and clinical evaluation and management of the athlete with a closed head injury.
3. To gain a basic understanding of the return to play recommendations and the controversy over this issue.



# **Definition #1**

...“a clinical syndrome characterized by immediate and transient post-traumatic impairment of neural functions, such as alteration of consciousness, disturbance of vision, equilibrium, etc. due to brain stem involvement”

or

traumatically altered mental status

**Committee of Head Injury Nomenclature of the  
Congress of Neurologic Surgeons**



## **Definition #2**

**...a complex pathophysiological process affecting the brain, induced by traumatic biomechanical force...from direct blow or transmitted force...with rapid onset of short-lived impairment of neurologic function that resolves spontaneously**

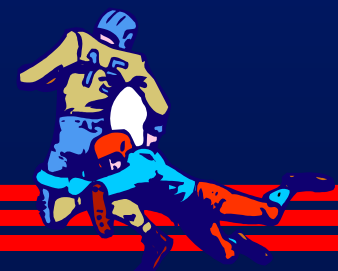
**1<sup>st</sup> International Conference on Concussion in Sports**





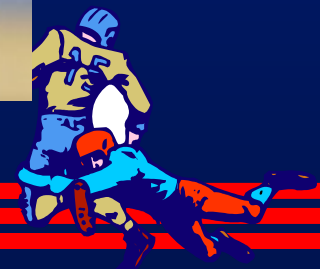
# **Epidemiology**

- **1 mil traumatic brain injuries per yr in US**
- **Incidence=100:100,000**
- **50,000 deaths**
- **M:F 2:1**
- **Bimodal peak**
  - **15-24 & >75**



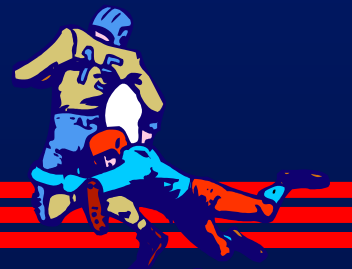
# **Epidemiology**

- 250,000 concussions/yr in contact sports
- 50-80% minor head injuries
- 1.5 mil HS football players/yr
- 1 in 5 HS football players
- 8 deaths/yr in football



# ***High Risk Team Sports***

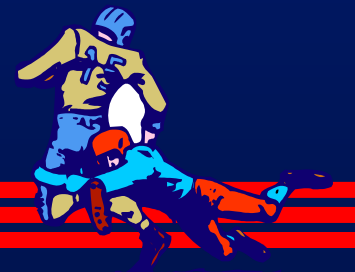
- **Football/Rugby**
- **Gymnastics**
- **Hockey**
- **Wrestling**
- **Lacrosse**
- **Equestrian Sports**
- **Martial Arts**





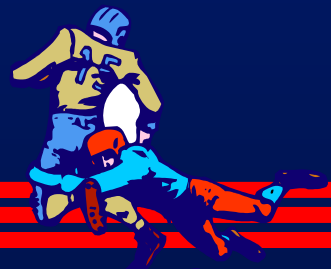
# ***High Risk Recreational Sports***

- **Skiing**
- **Biking**
- **Auto racing**
- **Sport diving**



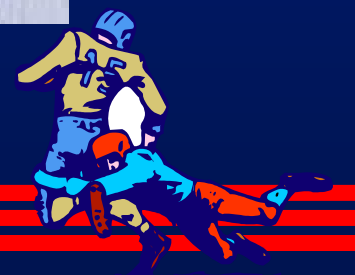
# ***Closed Head Injury***

- **Concussion**
- **Subarachnoid Hemorrhage**
- **Subdural/Epidural Hematoma**
- **Contusion**
- **Reactive Hyperemia**
- **Diffuse Swelling**



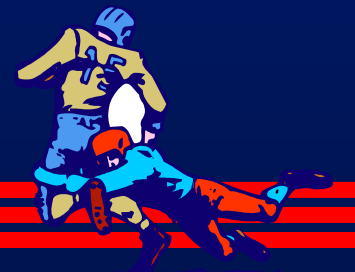
# ***Minimal Brain Injury***

- 50% - 80% of head injuries
- LOC 0- 20 minutes
- GCS > 13
- Normal neurologic exam
- PTA < 48 hours



# ***Histology of Damage***

- **Traction and shearing of axons**
- **Microinfarcts**
- **Edema**
- **Scar formation**
- **Local metabolic dysfunction**
  - **Glycolysis and abn blood flow**



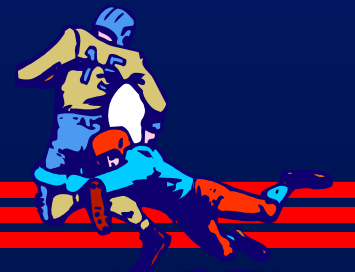
# **Presentation**

- **Loss of Consciousness (LOC)**
- **Altered Consciousness (Dinged)**
- **Amnesia**
  - **Antegrade**
  - **Retrograde (PTA)**
- **Disorientation**
- **Sleepiness**
- **Abnormal coordination/balance**
- **Abnormal reaction time**
- **Poor concentration & comprehension**
- **Opposition or other behavior change**
- **Diplopia**
- **Incontinence**



# ***On Field Observations***

- Vacant stare
- In coordination
- Poor performance
- Wrong huddle
- Distracted
- Inappropriate behavior
- Slurred speech



Determine level of consciousness

Unconscious

Conscious

Not Breathing

Breathing

Neuro Exam

Call for help

Call for Help

Remove from field

C-spine

C-spine

Observe

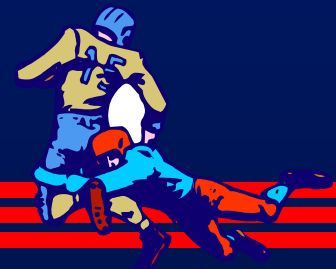
CPR /Airway/IV

Neuro Exam

Transport if..  
Abn exam or  
Severe mechanism

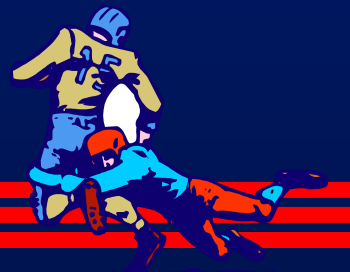
Transport

Transport



# ***Immediate Transport***

- **Diplopia**
- **Severe or increasing emesis**
- **Seizure**
- **Focal neurologic findings**
- **Pupillary changes**
- **Rapidly progressive headache**
- **Penetrating injury**
- **LOC > 5 min**
- **Confusion > 30 min**
- **High risk patient**
- **> 1 concussion this season**





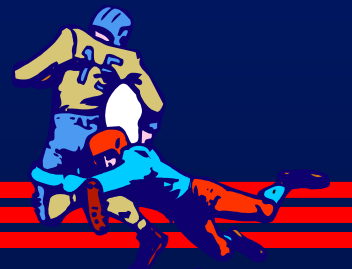
# ***Sideline Evaluation***

- Maddocks Questions
- SAC



# ***Maddocks Questions***

- **What field are we at?**
- **What team are we playing?**
- **What period is it?**
- **How far into the period is it?**
- **Who scored last?**
- **Who did we play last week?**
- **Did we win last week?**



## Standardized Assessment of Concussion

### 1) ORIENTATION:

Month: \_\_\_\_\_ 0 1  
 Date: \_\_\_\_\_ 0 1  
 Day of week: \_\_\_\_\_ 0 1  
 Year: \_\_\_\_\_ 0 1  
 Time (within 1 hr.): \_\_\_\_\_ 0 1

Orientation Total Score \_\_\_\_\_ / 5

2) **IMMEDIATE MEMORY:** (all 3 trials are completed regardless of score on trial 1 & 2; total score equals sum across all 3 trials)

List	Trial 1	Trial 2	Trial 3
Word 1	0 1	0 1	0 1
Word 2	0 1	0 1	0 1
Word 3	0 1	0 1	0 1
Word 4	0 1	0 1	0 1
Word 5	0 1	0 1	0 1
<b>Total</b>			

Immediate Memory Total Score \_\_\_\_\_ / 15

(Note: Subject is not informed of Delayed Recall testing of memory)

### NEUROLOGICAL SCREENING:

Loss of Consciousness: (occurrence, duration)

Retrograde & Posttraumatic Amnesia: (recall of events pre- and post-injury)

Strength:

Sensation:

Coordination:

### 3) CONCENTRATION:

Digits Backward (If correct, go to next string length. If incorrect, read trial 2. Stop after incorrect on both trials)

4-9-3      6-2-9      \_\_\_\_\_ 0 1  
 3-8-1-4      3-2-7-9      \_\_\_\_\_ 0 1  
 6-2-9-7-1      1-5-2-8-6      \_\_\_\_\_ 0 1  
 7-1-8-4-6-2      5-3-9-1-4-8      \_\_\_\_\_ 0 1

Months in reverse order: (entire sequence correct for 1 point)

Dec-Nov-Oct-Sep-Aug-Jul  
 Jun-May-Apr-Mar-Feb-Jan      \_\_\_\_\_ 0 1

Concentration Total Score \_\_\_\_\_ / 5

### EXERTIONAL MANEUVERS

(when appropriate):

5 jumping jacks      5 push-ups  
 5 sit-ups      5 knee-bends

### 4) DELAYED RECALL

Word 1      0 1  
 Word 2      0 1  
 Word 3      0 1  
 Word 4      0 1  
 Word 5      0 1

Delayed Recall Total Score \_\_\_\_\_ / 5

### SUMMARY OF TOTAL SCORES:

Orientation      \_\_\_\_\_ / 5  
 Immediate Memory      \_\_\_\_\_ / 15  
 Concentration      \_\_\_\_\_ / 5  
 Delayed Recall      \_\_\_\_\_ / 5

Overall Total Score \_\_\_\_\_ / 30

FIG. 1. Standardized Assessment of Concussion.



## 1) ORIENTATION:

Month: \_\_\_\_\_ 0 1

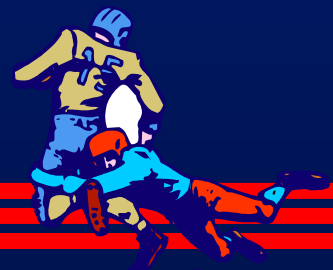
Date: \_\_\_\_\_ 0 1

Day of week: \_\_\_\_\_ 0 1

Year: \_\_\_\_\_ 0 1

Time (within 1 hr.): \_\_\_\_\_ 0 1

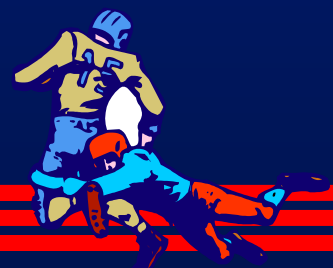
**Orientation Total Score** \_\_\_\_\_ / 5



**2) IMMEDIATE MEMORY:** (all 3 trials are completed regardless of score on trial 1 & 2; total score equals sum across all 3 trials)

<b>List</b>	<b>Trial 1</b>	<b>Trial 2</b>	<b>Trial 3</b>
Word 1	0 1	0 1	0 1
Word 2	0 1	0 1	0 1
Word 3	0 1	0 1	0 1
Word 4	0 1	0 1	0 1
Word 5	0 1	0 1	0 1
<b>Total</b>			

**Immediate Memory Total Score** \_\_\_\_\_ / 15



### 3) CONCENTRATION:

Digits Backward (If correct, go to next string length. If incorrect, read trial 2. Stop after incorrect on both trials)

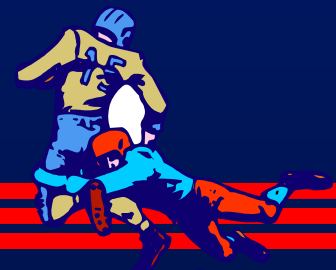
4-9-3	6-2-9	_____	0	1
3-8-1-4	3-2-7-9	_____	0	1
6-2-9-7-1	1-5-2-8-6	_____	0	1
7-1-8-4-6-2	5-3-9-1-4-8	_____	0	1

Months in reverse order: (entire sequence correct for 1 point)

Dec-Nov-Oct-Sep-Aug-Jul

Jun-May-Apr-Mar-Feb-Jan \_\_\_\_\_ 0 1

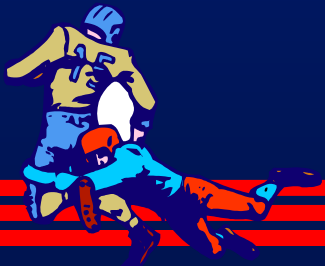
**Concentration Total Score** \_\_\_\_\_ / 5



#### 4) DELAYED RECALL

Word 1	0	1
Word 2	0	1
Word 3	0	1
Word 4	0	1
Word 5	0	1

**Delayed Recall Total Score** \_\_\_\_\_ / 5



# NEUROLOGICAL SCREENING:

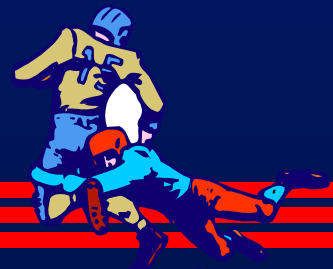
Loss of Consciousness: (occurrence, duration)

Retrograde & Posttraumatic Amnesia:  
(recall of events pre- and post-injury)

Strength:

Sensation:

Coordination:







## EXERTIONAL MANEUVERS

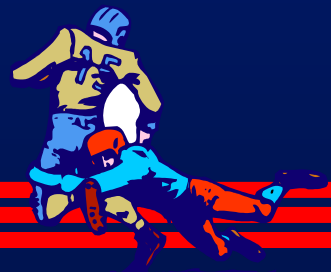
(when appropriate) :

**5 jumping jacks**

**5 sit-ups**

**5 push-ups**

**5 knee-bends**



## SUMMARY OF TOTAL SCORES :

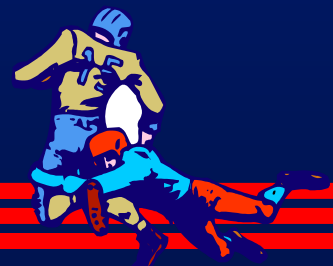
*Orientation* \_\_\_\_\_ / 5

*Immediate Memory* \_\_\_\_\_ / 15

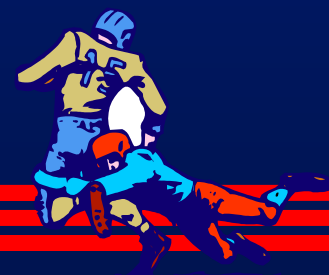
*Concentration* \_\_\_\_\_ / 5

*Delayed Recall* \_\_\_\_\_ / 5

**Overall Total Score** \_\_\_\_\_ / 30

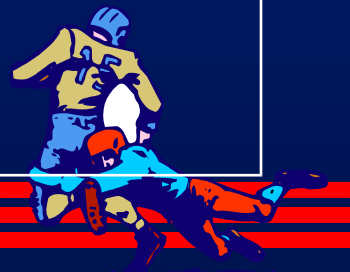


# ***GRADING***



# **American Academy of Neurology**

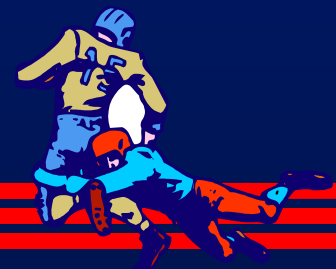
<b>Grade I</b>	<b>Grade II</b>	<b>Grade IIIa</b>	<b>Grade IIIb</b>
<b>Transient Confusion  No LOC Resolve &lt;15 min</b>	<b>Transient Confusion  No LOC Sx &gt; 15 min</b>	<b>LOC &lt;15 min</b>	<b>LOC &gt;15 min</b>



# ***Is LOC Important?***

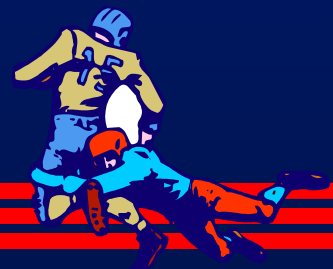
- Neuropsychological testing on 383 pts over 5 yrs with MBI
- LOC, no LOC or uncertain
- No relationship between LOC and neurological sequelae as evidence by testing

**Clin J Sport Med 1999; 9:195**



# Who to Scan?

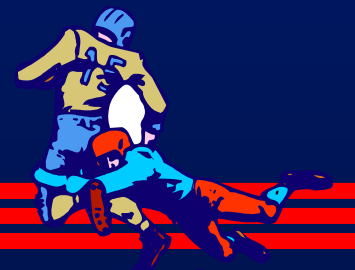
- GCS < 15
- Abnormal MSE
- ? Any LOC
- Focal neurologic findings



# **Canadian CT Head Rule**

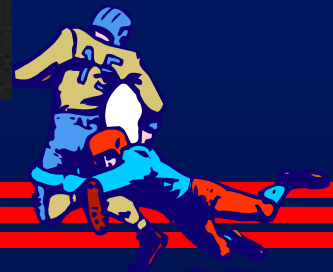
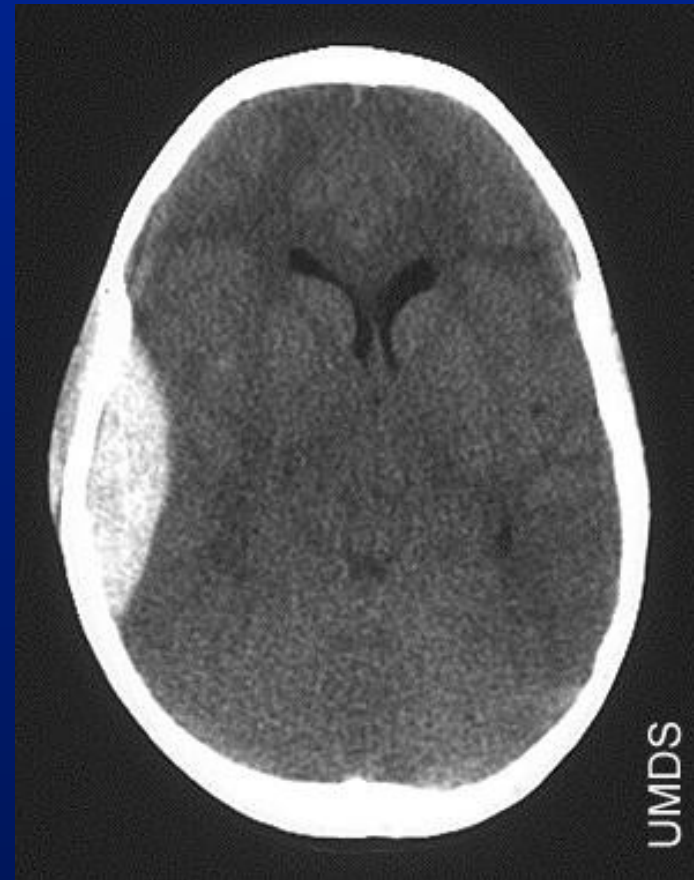
- **Hi**  
**ne**  
**in** **\*2078 CT's performed**  
**over 3 years**
- **\*348 abn**
- **320/348 identified by**
- **applying these rules**
- **Vomit >2**
- **Age>65**

**Lancet May 5,**  
**2001;357:1391**



# CT

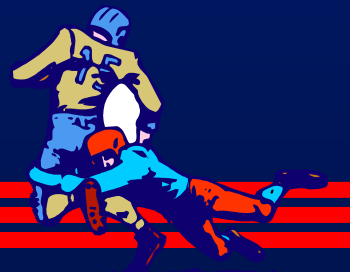
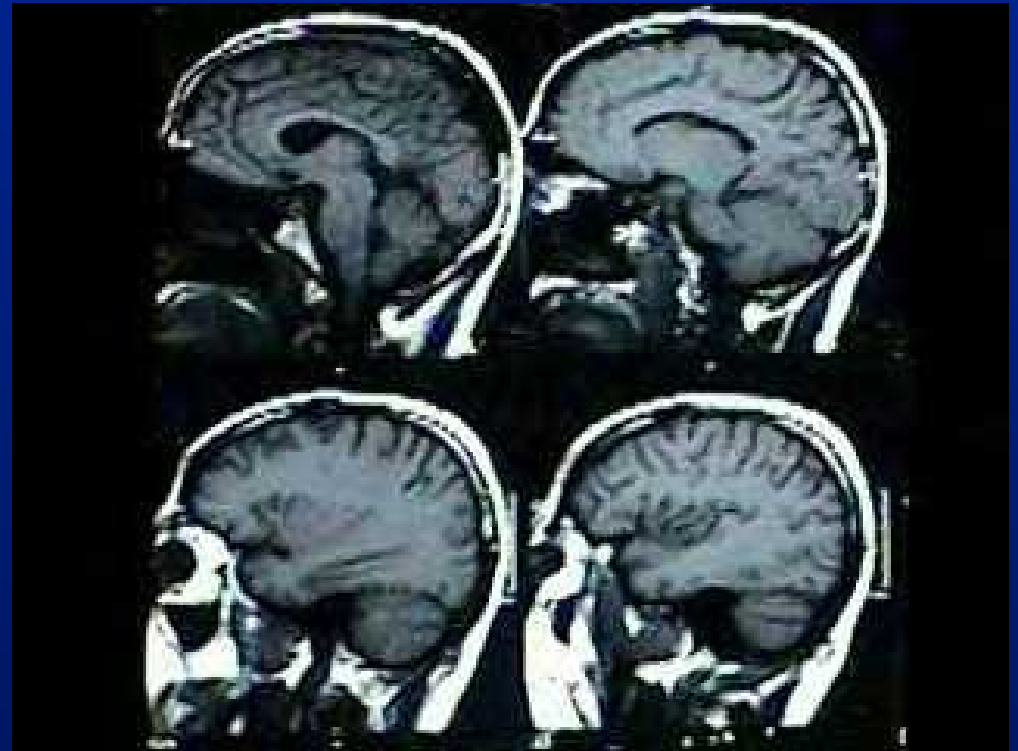
- More useful in the acute setting for significant injury
  - SDH/EDH/SAH





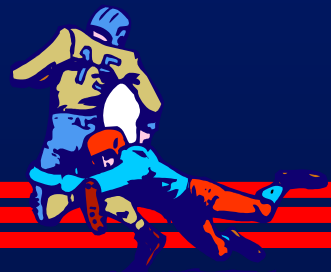
# **MRI**

- **75% abnormal within days**
- **Most findings resolve in 3 months**
- **May help predict clinical course**
- **Abnormal findings may not correlate with neuropsychiatric findings**
- **Unknown long term issues**



# ***Consider MRI for...***

- Prolonged post-concussive symptoms
- Marked or persistent neuropsychiatric problems



# Post-concussive Syndrome

- 20% to 40% @ 3 months post injury
- Neuropsychiatric impairments
  - attention concentration
- Somatic
  - headache (71%)
  - fatigue (60%)
  - dizziness (53%)
- Affective – depression or anxiety

## COVER STORY

### LaFontaine back after hit of a lifetime

By Sharon Raboin  
USA TODAY

After tucking in their three young children, Marybeth LaFontaine crawled into bed and turned on the television.

She clicked on the Buffalo Sabres hockey game to watch her husband, Pat, that night in October 1996. "I noticed I didn't see LaFontaine on the bench or hear his name," she says.

That's because LaFontaine absorbed a hit with such impact that it knocked off his helmet and his head smacked the ice.

Watching the replay, Marybeth was alarmed, even though Pat phoned about an hour later while driving home to assure her that he was fine. He wasn't, though.

Pittsburgh Penguins defenseman Francois Leroux's open-ice hit to LaFontaine's head gave the Sabres star center a severe concussion and medical problems, forcing him to miss 69 games and putting his career in jeopardy.

But LaFontaine wasn't ready to cut his career short, and he came back this season.

"It's very surprising a guy would want to come back and take a chance," New York Rangers trainer Jim Ramsay says.

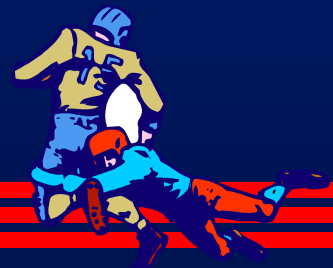
LaFontaine, traded to the Rangers in September, plays tonight at New Jersey, subjecting his fragile, 5-10, 180-pound



By Cher Gordon, Gannett Suburban Newspapers

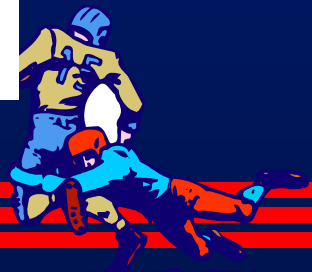
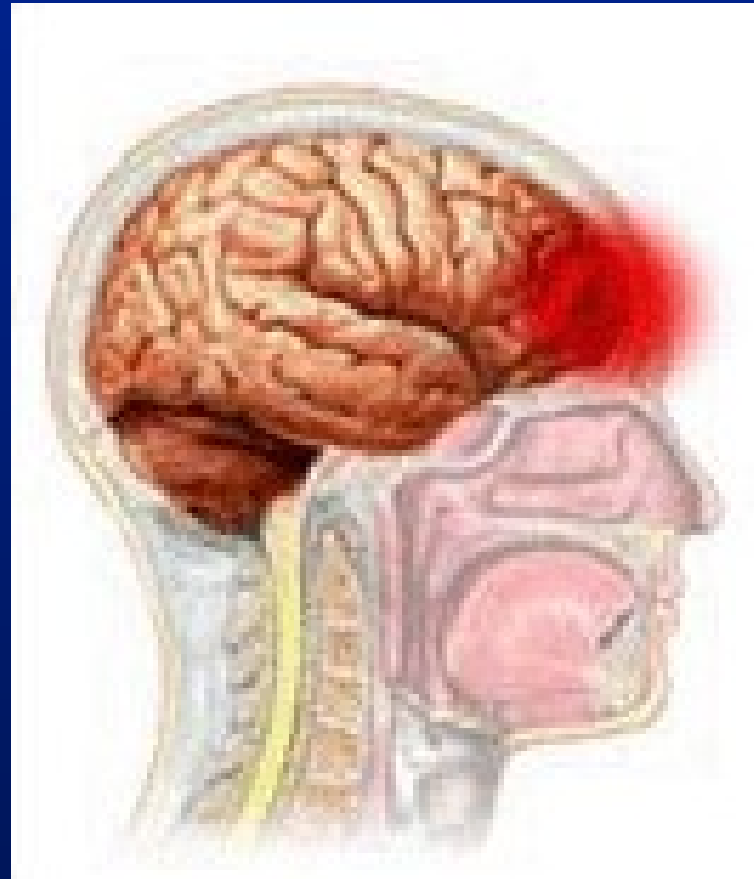
**His game face:** Pat LaFontaine of the New York Rangers is doing well after missing 69 games with a concussion.

Please see COVER STORY next page ►



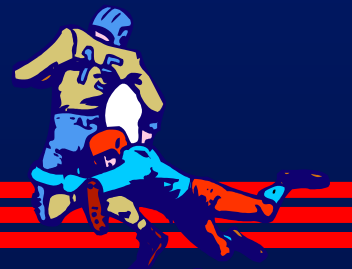
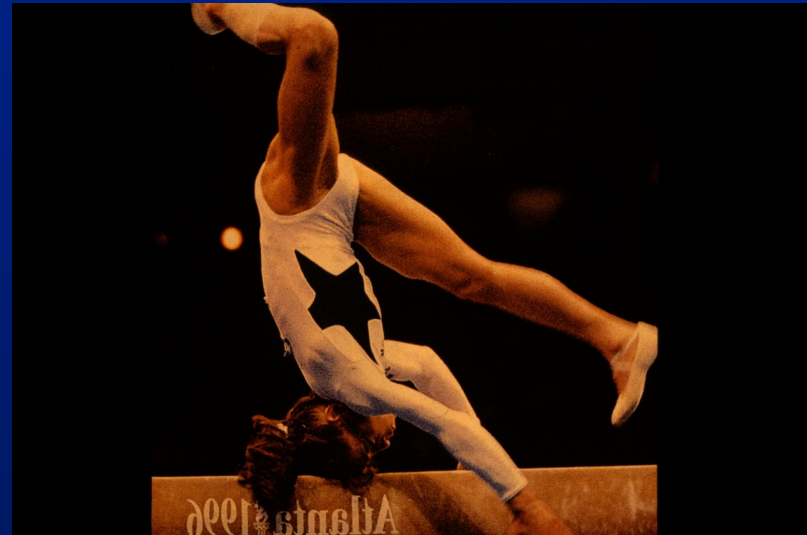
# **Epilepsy**

- Seizure with 1 week post injury
- PTA > 12 hrs
- Intracranial hemorrhage
- Fixed neurologic deficit
- EEG not helpful



# **Psychiatric**

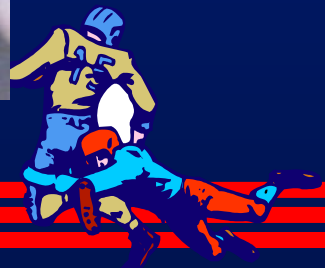
- Depression
- Headaches
- Anxiety
- Poor dreaming





# **Cognitive/Neurobehavioral**

- Unknown long term effects
- Abn testing noted in F/U testing up to 4 months
- Poor memory, info processing speed, attention, problem solving, and word fluency



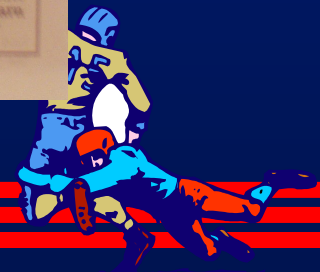
# **Monitoring Brain Dysfunction**

- Neuropsychiatric testing
  - attention, STM, concentration, visospatial ability, motor function
- Trail A&B, Stroop color-word test, VIGIL-W



# Neuropsychiatric Testing

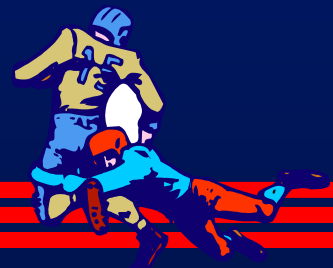
- **ImPACT**
  - [www.impacttest.com](http://www.impacttest.com)
- **HeadMinder**
  - [www.headminder.com](http://www.headminder.com)
- **CogSport**
  - [www.cogsport.com](http://www.cogsport.com)
- **ANAM**





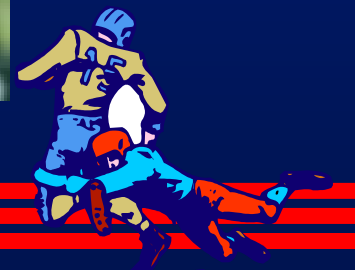
# **Computer-based Neuropsychiatric Testing**

- No learning effect
- Data storage and comparison to baseline
- Easy to administer in Training Room
- 15-20 minutes



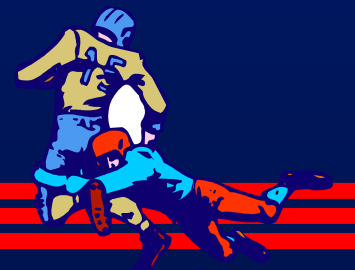
# ***Neuropsychiatric Testing***

- **Acute injury**
  - Memory and attention
- **Recovery/RTP**
  - Information processing



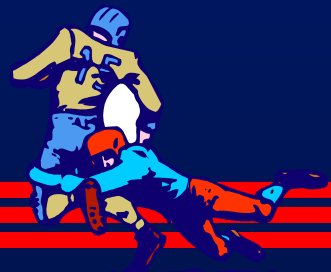
# ***Follow up Care***

- **First 24 hrs**
  - **Serial neurologic evaluations**
  - **Every 2-3 hrs**
- **Avoid sedating medications,**
  - **narcotics, alcohol, antihistamines**
- **Ice, Tylenol, light diet**



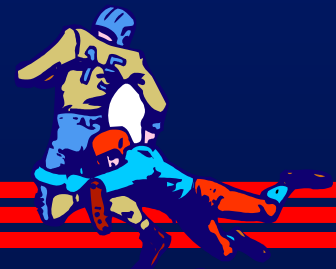
# ***Follow-up Care***

- **Avoid contact activities**
- **Warn about possible difficulty with reading, homework, and testing**



# ***Disposition and Treatment***

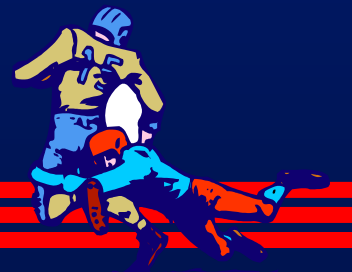
- **Second Impact Syndrome**
- **Post-concussive Symptoms**
- **Cumulative Effect?**





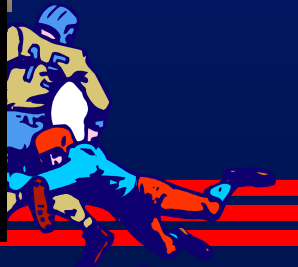
# ***Second Impact Syndrome***

- **Pathology**
  - **Abnormal autoregulation**
  - **Cerebral vascular congestion**
  - **Diffuse edema/ ICH**
  - **Midbrain herniation**
- **Sudden collapse**
- **Dilated pupils**
- **Respiratory failure**
- **Rapid deterioration and death**



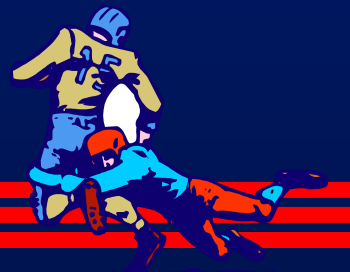
# ***Recurrent Injury***

- MBI may diminish cerebral reserve
- 2-4 times more likely to sustain a second injury
- More prolonged disability with repeat injuries
- Consider cognitive testing



# ***Return to Play***

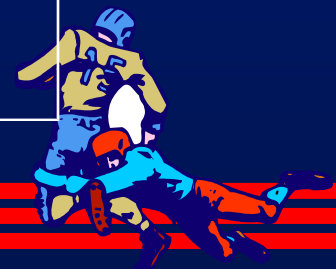
**No symptomatic athlete  
should be allowed to  
compete until symptoms  
have cleared**





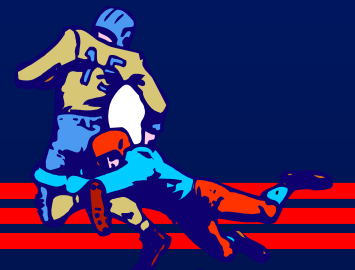
# **American Academy of** **Neurology**

<b>Grade</b>	<b>1<sup>st</sup> Concussion</b>	<b>2<sup>nd</sup> Concussion</b>	<b>3<sup>rd</sup> Concussion</b>
<b>Grade I No LOC Sx &lt;15 min</b>	<b>RTP if Asx in 15 min</b>	<b>Asx for 1 wk</b>	<b>Asx for 1 wk</b>
<b>Grade II No LOC Sx &gt;15 min</b>	<b>Asx for 1 wk</b>	<b>2 weeks Asx for 1 wk</b>	<b>2 weeks Asx for 1 wk</b>
<b>Grade III a Brief LOC</b>	<b>Asx for 1 wk</b>	<b>1 month or longer</b>	<b>1 month or longer</b>
<b>Grade III b Prolonged LOC</b>	<b>Asx for 2 weeks</b>	<b>?</b>	<b>?</b>



# **1<sup>st</sup> International Conference**

1. No activity with complete rest
2. Light aerobic exercise-walk or stationary bike
3. Sport-specific exercise (skate, run, swim, ...)
4. Non-contact training drill
5. Full contact training after medical clearance
6. Game play



# ***Return to Play Process***

**Symptom free at rest**



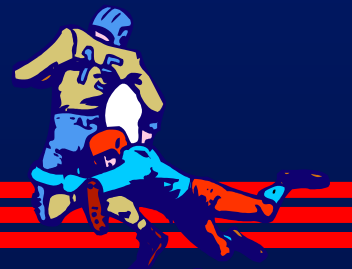
**Symptom  
free with  
exercise**



**Normal Neuropsychiatric Testing**



**Return**



# 2nd International Conference on

Eliminate Grading

Simple or Complex Concussion

More emphasis on amnesia

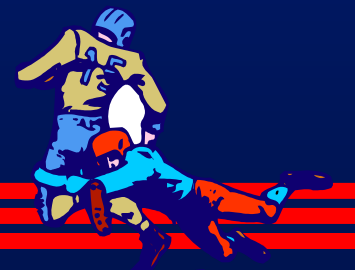
“Cognitive rest” in Pediatric Concussion

SCAT

Individualized stepwise RTP

No same game RTP

Neuropsychological testing for complex concussions on asymptomatic athletes



# ***Future Trends***

- **Return to play**
  - **More use of Neuropsychiatric Testing**
  - **Imaging-f MRI, PET, SPECT)**

